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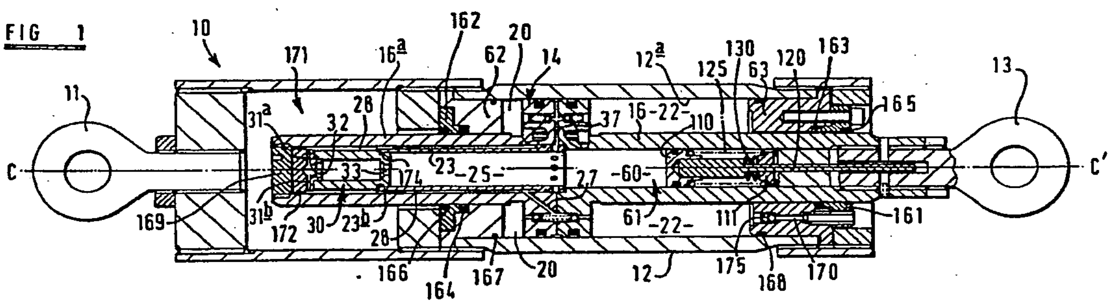
(58) Field of search
F2S

(54) Hydraulic shock arrestor for pipes; valves

(57) A shock arrestor comprises a cylinder 12, a piston 14 slidably mounted in the cylinder and which divides the cylinder into respective fluid chambers 20, 22, passage means 27, 28, 31, 32, 33, 37 being provided through which fluid may flow in one direction between the chambers regardless of the direction of piston movement. Flow control means 30 (shown in detail in Fig. 4) is provided to restrict the flow of fluid through the passage means, to restrain movement of an article to which the shock arrestor is connected. The flow control means comprises a pressure responsive spool valve 72 located within a valve chamber, located within the piston rod 16a of the shock arrestor, the spool valve being operative to permit flow between the chambers at relatively low flow rates, but at least significantly to restrict such flow when the flow rate becomes excessive, the apertures 77a and 78a moving out of alignment. Notwithstanding the restriction of flow in such circumstances, means is provided to permit at least limited flow between the chambers, to accommodate for thermal expansion or contraction. A member 71 forming the housing for the spool valve 72 moves off its seat 103 against the bias of spring 101 to open a creep passage 104. A reserve volume fluid chamber 60 is provided, also located within the piston rod, from which fluid may flow into one of the chambers to prevent cavitation.

FIG 1



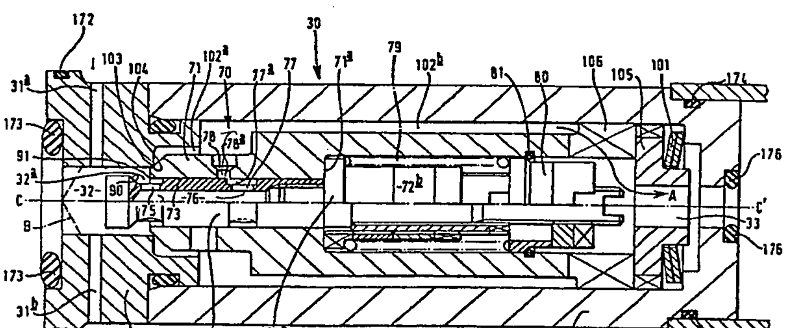


FIG 4

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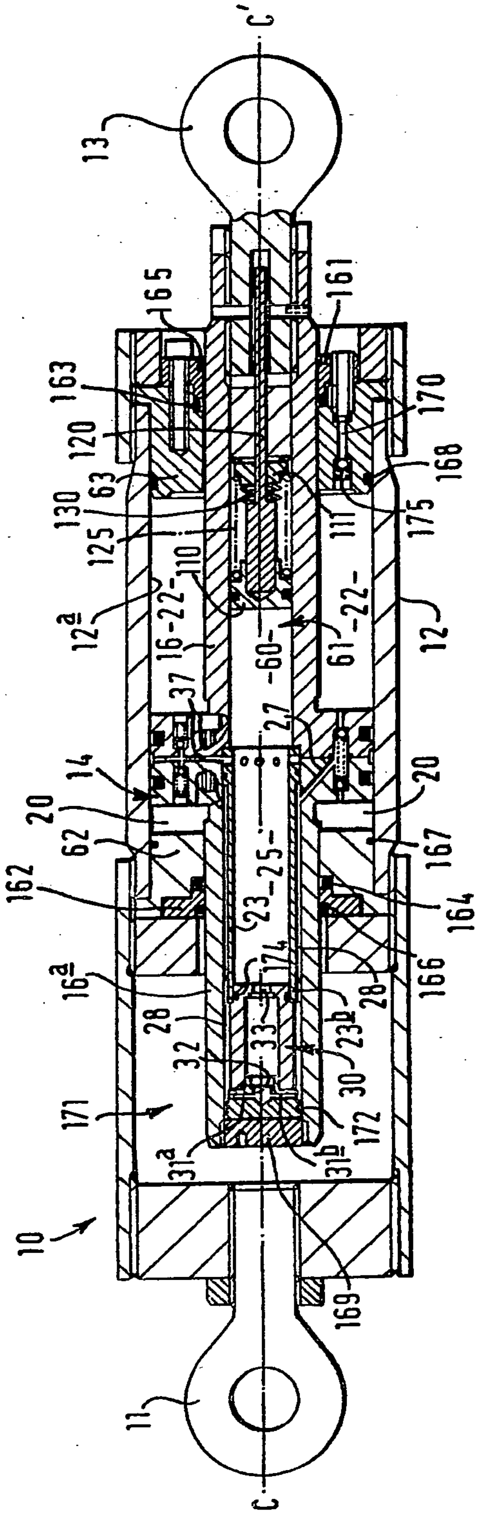
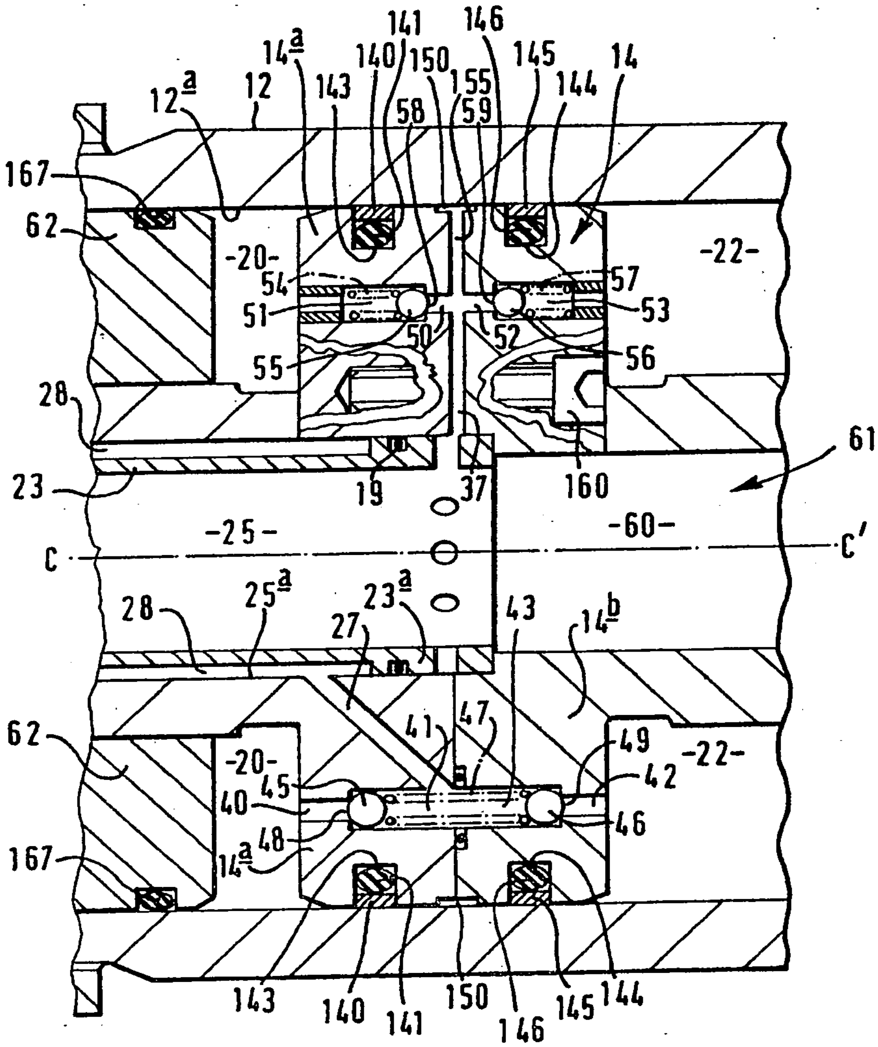


FIG 1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-60-
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28
25a
23a
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14b
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FIG 2

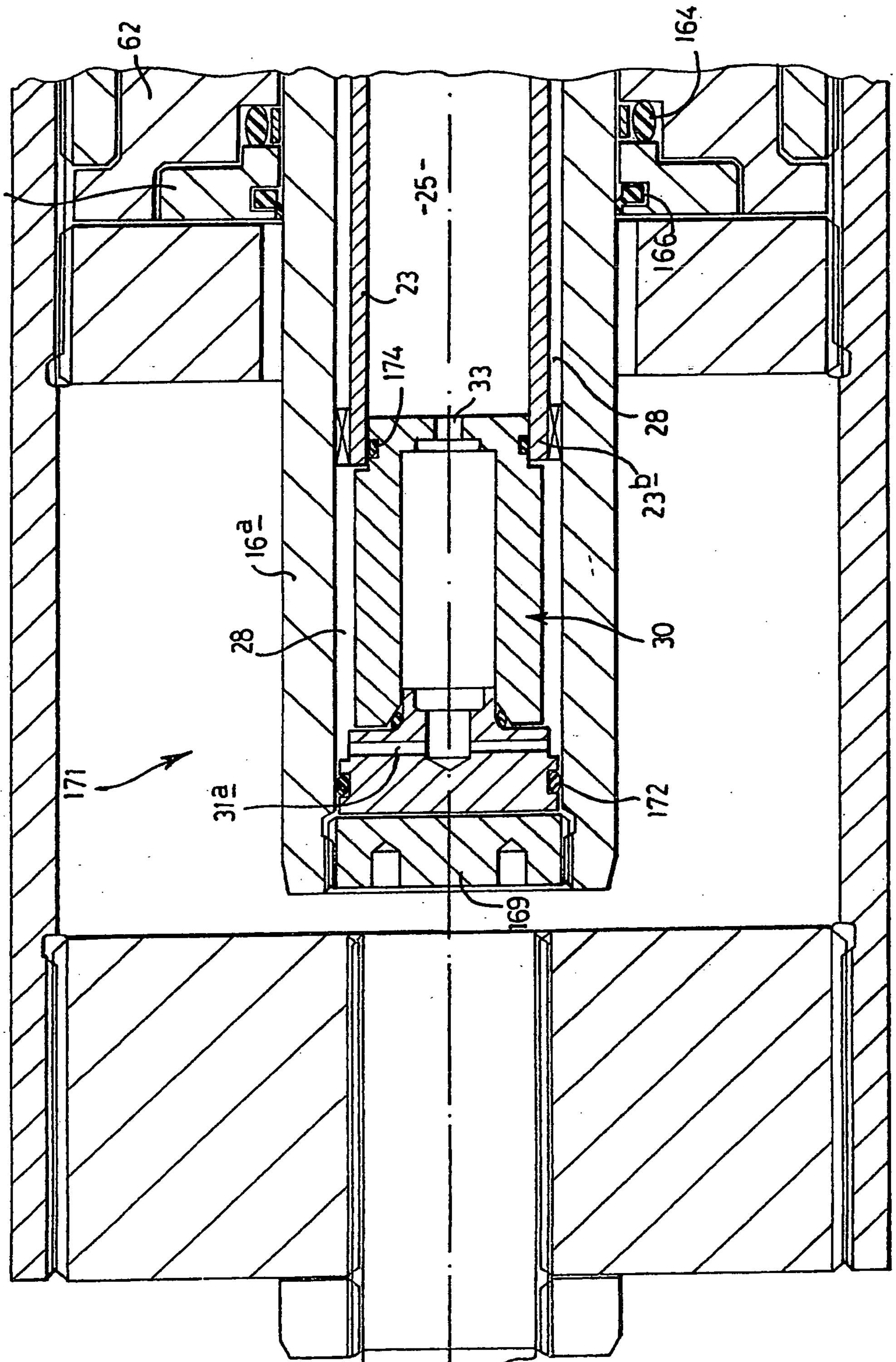

FIG 3

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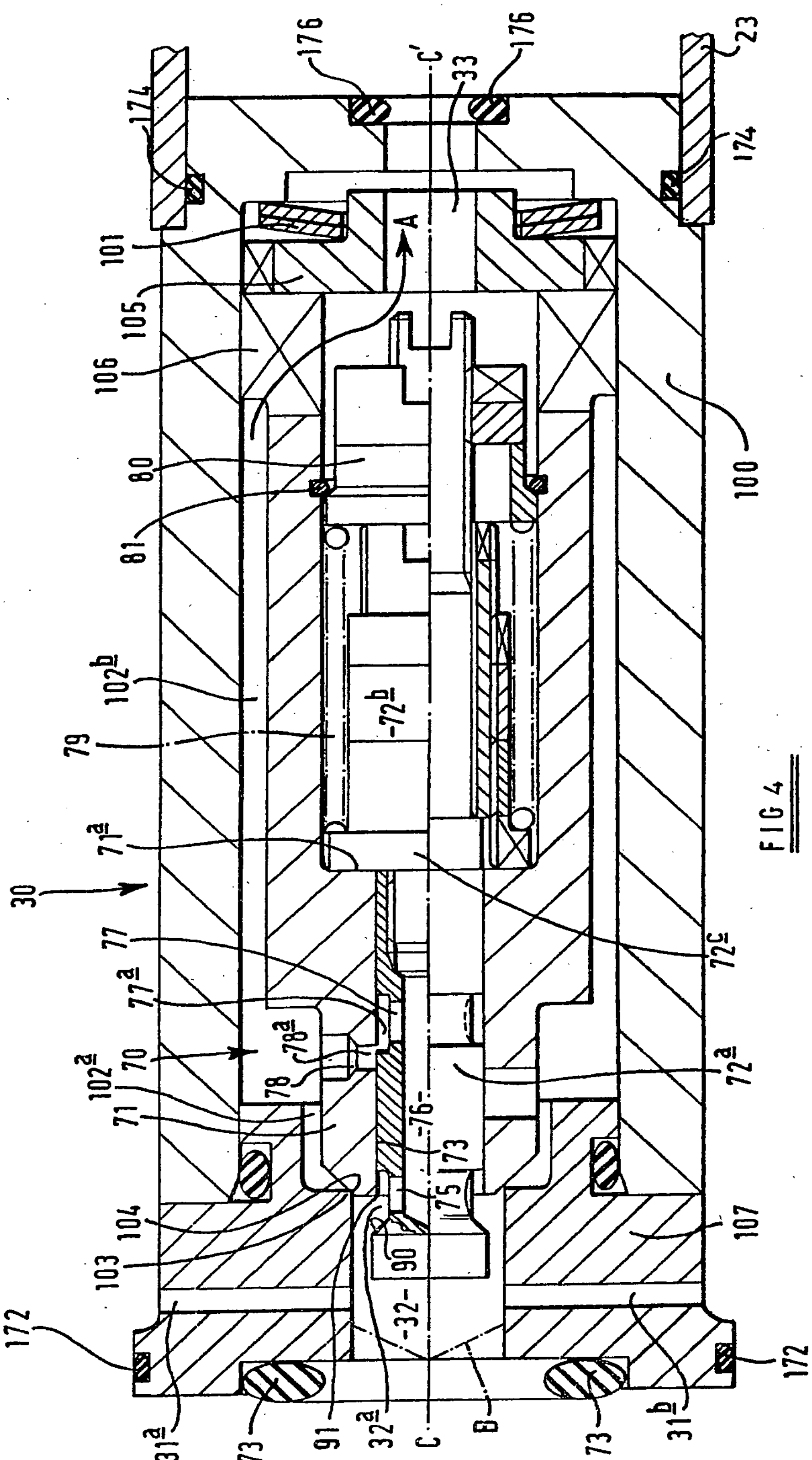

FIG 4

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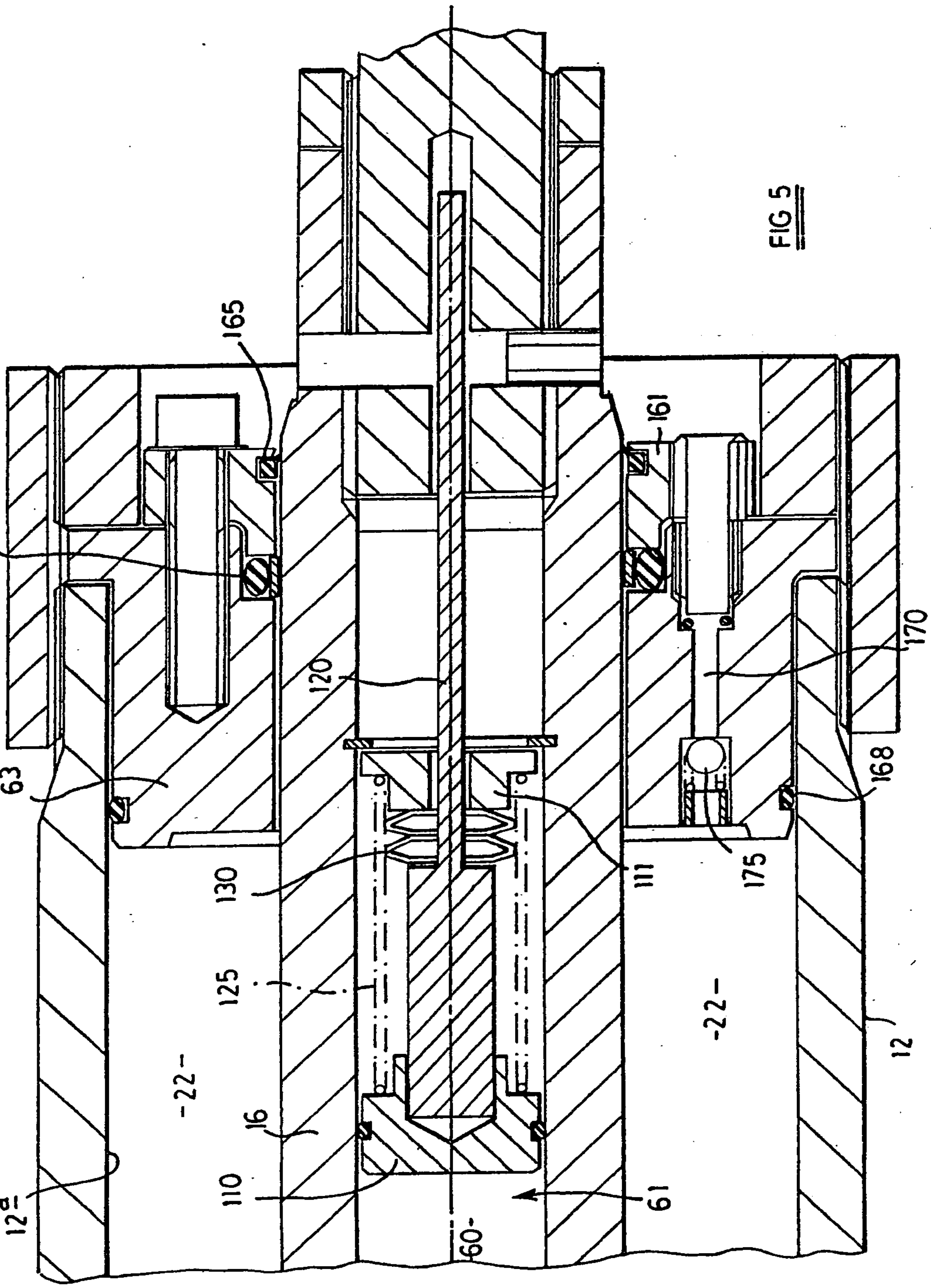

FIG 5

SPECIFICATION
Improvements Relating to Shock Arrestors

This invention relates to shock arrestors of the kind which restrains movement of an article to which the shock arrestor is connected, and in particular to shock arrestors of the kind (hereinafter referred to as being of the kind specified) comprising a cylinder, a piston slidably mounted in the cylinder and dividing the cylinder into respective fluid chambers, passage means between the fluid chambers through which fluid may flow between the two chambers, and flow control means to restrict such flow of fluid.

In the use of a shock arrestor of the kind specified, conventionally the cylinder, or a part secured thereto, is connected to a support structure, and the piston or part secured thereto is connected to the article, although if desired, such connections may be reversed.

The invention also relates to a valve device suitable for use in a shock arrestor of the kind specified or for use in any other fluid-employing device.

The invention further relates to a method of restraining movement of an article by using a shock arrestor in accordance with the invention, and to a method of at least significantly restricting fluid flow by using a valve device in accordance with the invention.

According to a first aspect of the invention, there is provided a shock arrestor of the kind specified wherein the flow control means is operative to permit flow between the chambers at relatively low flow rates but at least significantly to restrict such flow when the flow rate becomes excessive.

In this manner, the shock arrestor permits movement of an article to which it is connected at relatively low speeds but at least significantly restrains such movement when the speed of the article becomes excessive.

The flow control means may further comprise creep means to permit very low flow rates of fluid even when the flow between the chambers is significantly restricted.

In this manner, even when the movement of the article is significantly restrained, very slow movements of the article are possible in response, for example, to thermal expansions or contractions of the article and/or shock arrestor and/or fluid.

Preferably, the flow control means is located substantially within the normal confines of the cylinder.

The flow control means may further comprise valve means which under normal conditions of operation is in an open condition and which on excessive pressure differential between the two chambers, such as is caused by excessively rapid movement of the article to which the arrestor is connected, moves or is moved to a closed condition in which it provides a significant restriction to flow of fluid therethrough.

Thus, when the valve means is in its closed condition, flow of fluid from the first chamber to the second chamber (or vice versa) through the valve means is substantially prevented, restraining movement of the article to which the shock arrestor is connected. The valve means may be retained in its closed position by the pressure differential between the two chambers, as would be produced by a continued large force tending to move the article. However, advantageously, the valve means is urged towards its open position by resilient means, permitting the valve means to move from its closed position when the pressure differential reduces to a level below said excessive level.

The shock arrestor may be adapted so that fluid flow between said chambers in either direction results in the same direction of flow of fluid through the valve means.

In this manner, the valve means is required to be responsive to fluid flow in only one direction, and may therefore have a simpler construction than would otherwise be required.

According to a second aspect of this invention, there is provided a shock arrestor of the kind specified wherein the flow control means is located within a piston rod movable in the cylinder with the piston rod.

According to a third aspect of this invention, there is provided a shock arrestor of the kind specified comprising a valve chamber in which the flow control means is located, and valve means in the valve chamber, means being provided which is operative to produce unidirectional flow of fluid through the valve chamber in both directions of movement of the piston.

Preferably, the valve chamber is located within a piston rod movable in the cylinder with the piston.

The shock arrestor may comprise a flow control means in accordance with a fourth aspect of the invention, as will now be described.

According to said fourth aspect of the invention, there is provided a flow control means suitable for use in a shock arrestor of the kind specified, or for use in any other fluid-employing device, the flow control means comprising the valve device comprising at least one flow passage through which fluid flows during normal operation of the shock arrestor or other fluid-employing device, and a valve member operative in relation to the flow passage and which is movable from an open position to a closed position by differential fluid pressure acting on the valve member when the fluid flow reaches or exceeds a threshold velocity.

When the flow control means is used in a shock arrestor of the kind hereinbefore described, fluid flow between the chambers via the valve means is permitted at relatively low flow rates but is at least significantly restricted by the valve device when the flow rate becomes excessive, so as then to restrain movement of the piston, and hence so as at least significantly to restrain movement of the article when the speed of the article becomes excessive.

The normal fluid flow may be through an aperture in a surface of the valve member and a further aperture at an end of said flow passage, said further aperture lying in a further surface of the valve device, said surface and said further surface slidably abutting each other, said apertures at least partially

overlapping each other when the valve member is at the open position, but not overlapping each other when the valve member has moved to the closed position.

Said movement of the valve member from the open position to the closed position may additionally cause closure of a further fluid passage through which fluid flows during normal operation of the shock arrestor or other fluid-employing device.

The flow control means may comprise a creep device comprising a component which is urged so as normally to close an opening of an auxiliary flow passage by-passing said flow passage, said component being movable against said urging so as to open the opening and permit fluid flow along said auxiliary passage.

The creep device may be provided by said creep means of the shock arrestor. In this manner, fluid flow along the auxiliary passage reduces possibly harmful stresses arising from pressure differences caused by thermal expansion or contraction of the fluid and/or shoch arrestor (or other fluid-employing device).

The passage means may comprise a bore formed in a piston rod movable with the piston, the flow control means being located within the bore, an inlet passage means being provided to admit fluid unidirectionally from either chamber to an inlet means of the flow control means, and an outlet passage means being provided to admit fluid unidirectionally to either chamber from an outlet means of the flow control means.

The shock arrestor may further comprise a reserve volume fluid chamber in communication with the passage means.

The reserve volume fluid chamber may be located in a region of the shock arrestor also containing a slidable member urged by a compression spring acting between the slidable member and a part of said region so as to pressurise the fluid in the reserve volume fluid chamber.

In this manner, fluid from the reserve volume fluid chamber may be admitted to either of said fluid chambers when movement of the piston causes either of the chambers to increase in volume, thereby reducing risk of cavitation within the chamber whose volume is increasing.

A further compression spring may be provided between said slidable member and said part. In this manner, the slidable member is able to move against said further spring in response to thermal volume changes of the shock arrestor and/or fluid. Said region may lie within the piston rod.

The shock arrestor may have an indicator visible from outside the shock arrestor showing the pressure of the fluid within the shock arrestor.

Said fluid may be a liquid such as a conventional hydraulic fluid.

The shock arrestor may have a user-accessible bleed means for bleeding air from the shock arrestor and a user-accessible self-sealing filling passage for admitting fluid under pressure to the shock arrestor.

According to a fifth aspect of the invention, there is provided a shock arrestor of the kind specified further comprising a reserve volume fluid chamber in communication with the passage means.

The piston exterior may be provided with two annular, transversely oriented, longitudinally spaced seals which slidably abut the inner surface of the cylinder, the seals being located in respective annular channels around the piston exterior and each having an outer annular part which is urged against the cylinder by respective inner annular parts of the seals, the exterior of the piston at a location between the seals being in fluid communication with the reserve volume fluid chamber.

In this manner, excessive fluid pressure between said seals in avoided, thus avoiding seal retention problems which could otherwise arise.

According to a sixth aspect of the invention, there is provided a shock arrestor of the kind specified wherein the piston is formed from two substantially circular or annular portions secured to each other in a back-to-back relationship. In this manner, where the shock arrestor also has inlet passage means and outlet passage means as hereinbefore described, manufacture of said inlet passage means and said outlet passage means is facilitated.

This invention also provides a method of permitting movement of an article at relatively low speeds, but at least significantly restraining movement of said article when the speed of the article becomes excessive, by connecting the article to a shock arrestor in accordance with the invention.

This invention also provides a method of permitting fluid flow at relatively low flow rates, but at least significantly restricting such flow when the flow rate becomes excessive, using a valve device in accordance with the invention.

One embodiment of a shock arrestor in accordance with the invention, which employs a valve device in accordance with the invention, will now be described, by way of example only, with reference to the accompanying drawings, wherein:

Figure 1 is a cross-sectional view of a shock arrestor according to the invention on a plane passing through the central axis C—C′ of the shock arrestor;

Figure 2 is to a larger scale than Figure 1 and is a cross-sectional view on said plane of a portion of the shock arrestor of Figure 1;

Figure 3 is to a larger scale than Figure 1 and is a cross-sectional view in the plane of the longitudinal axis of the shock arrestor, showing a valve chamber of the shock arrestor within a piston rod thereof;

Figure 4 is a view similar to that shown in Figure 3 but to a larger scale, showing a valve means of the flow control means within the valve chamber; and

Figure 5 is to a larger scale than Figure 1 and is a cross-sectional view showing a reserve volume fluid chamber of the shock arrestor.

Referring to the drawings, a shock arrestor 10 comprises a cylinder 12 and a piston 14 within the cylinder 12, the piston 14 being located on a piston rod 16, 16*a* for longitudinal sliding movement with the piston rod 16, 16*a* within the cylinder 12. The piston 14 divides the cylinder 12 into respective fluid chambers 20 and 22.

In the use of the shock arrestor 10, an end part 11 secured to the cylinder 12 may be connected to a support structure, and a further end part 13 secured to the piston 14 via the piston rod portion 16 may be connected to an article whose movement is to be restrained, when appropriate, by the shock arrestor 10, although if desired such connections may be reversed.

Passage means between the fluid chambers 20 and 22 is provided for fluid to flow between the chambers 20 and 22, and a portion of the passage means through which fluid must flow in travelling between the chambers 20 and 22 comprises a coaxially formed portion 25 of a bore 25, 61 of the piston rod 16, 16*a*.

The bore portion 25 contains a conduit member 23 having outer dimensions which are less than the dimensions of the bore portion 25, so that there is a substantially cylindrical gap 28 between the conduit member 23 and the cylindrical wall 25*a* of bore portion 25. The conduit member 23 is sealed against the wall 25*a* at its end 23*a* adjacent to the piston 14. An elastomeric sealing ring 19 helps to ensure that there is no direct entry of fluid into the gap 28 from the bore 25, 61 via the end 23*a* of the member 23. An inlet passage means comprising inlet passages 27, 40, 41, 42 and 43 may admit fluid to the gap 28 from either of the chambers 20 or 22 by fluid flow via routes comprising inlet passages 40, 41, 27 or 42, 43, 27 respectively, for example in response to longitudinal movement of the piston 14 within the cylinder 12.

A flow control means indicated generally at 30 is sealed into the other end 23*b* of conduit member 23 so that fluid may flow from gap 28 through either or both of two flow routes 31*a* and 31*b* to an inlet means 32 of the flow control means 30. The fluid may then pass through the fluid control means 30 (if such flow is being permitted by the flow control means 30) and may leave the flow control means 30 via an outlet means 33 of the flow control means 30 so as to enter the interior of the conduit means 23. The fluid may then leave the interior of conduit means 23 via an outlet passage means comprising outlet passages 37, 50, 51, 52 and 53 by fluid flow along outlet passage 37 and then into the fluid chamber 20 or the fluid chamber 22 via respective flow routes 50, 51 or 52, 53.

The inlet passage means further comprises substantially spherical poppet members 45 and 46 respectively, which are urged away from each other by a spring 47 against respective openings 48 and 49 within respective flow routes 40, 41 and 42, 43.

The outlet passage means further comprises substantially spherical further poppet members 55 and 56 respectively which are urged by respective springs 54 and 57 so as to close respective openings 58 and 59 located within respective flow routes 50, 51 and 52, 53.

Wherever directional references, such as "left" or "right" are used herein, it is to be understood that the directional references are in relation to the drawings.

When the piston 14 is moved to the right, so as to decrease the volume of the chamber 22, and increase the volume of the chamber 20, there is a consequential fluid pressure increase in chamber 22 and a simultaneous fluid pressure decrease within chamber 20. The pressure increase in chamber 22 urges the further poppet member 56 against the opening 59 so as to seal the opening 59, and urges the poppet member 46 away from the opening 49 (against the urging of the spring 47) so as to open the opening 49. Fluid consequently leaves chamber 22 via the flow route 42, 43 and then travels along the inlet passage 27 into the gap 28. The pressure decrease within chamber 20 pulls the poppet member 45 against opening 48 so as to seal the opening 48, and pulls further poppet member 55 away from the opening 58 (against the urging of the spring 54) so as to open the opening 58. Fluid consequently enters the chamber 20 via the flow route 50, 51, having travelled along the outlet passage 37 from the interior of the conduit member 23.

If the piston 14 now moves towards the left, so as to decrease the volume of the chamber 20 and increase the volume of the chamber 22, there is a consequential fluid pressure increase within chamber 20 and a simultaneous fluid pressure decrease within chamber 22. The pressure increase within chamber 20 urges the further poppet member 55 against the opening 58 thus sealing the opening 58, and urges the poppet member 45 (against the urging of the spring 47) away from the opening 48 so as to open the opening 48. Fluid consequently flows out of chamber 20 via flow route 40, 41 and then travels via the inlet passage 27 into the gap 28. The pressure decrease within chamber 22 causes the poppet member 46 to be pulled against the opening 49 so as to seal the opening 49, and pulls further poppet member 56 away from the opening 59 (against the urging of the spring 57) so as to open the opening 59. Consequently, fluid from the interior of the conduit member 23 travels via the outlet passage 37 and then via the flow route 52, 53 into the chamber 22.

Thus flow of fluid in either direction between chambers 20 and 22 necessarily results in fluid flow into the gap 28 (and thence into the inlet means 32) together with fluid flow out of the interior of the conduit member 23, so that the corresponding fluid flow through the flow control means 30 is always in the same direction, namely from the inlet means 32 to the outlet means 33.

Referring particularly to Figures 3 and 4 of the drawings, a left-hand part of the piston rod defines a valve chamber within which a valve means 70 of the flow control means is located. The valve means 70 comprises a valve device having an outer member 71 and a valve member 72*a*, 72*b*. Valve member portion 72*a* is a close slidable fit against the interior of a bore 73 of the outer member 71. During normal permitted flow of fluid through the valve means 70, fluid enters a central conduit 76 of valve member portion 72*a* via an opening 75 in the portion 72*a*, and leaves the central conduit 76 via a further opening 77 in the portion 72*a*. The fluid then flows through a flow passage 78 located in the outer member 71, further opening 77 having a portion 77*a* in the outer

surface of portion 72*a* which overlaps a portion 78*a* of flow passage 78 in the surface of the bore 73. The portions 77*a* and 78*a* overlap each other during normal fluid flow so as normally to permit fluid to flow through the further opening 77, to the flow passage 78 through the area of overlap of the portions 77*a* and 78*a*, thereby permitting normal fluid flow through the valve means 70. After flowing through the flow passage 78, the fluid flows in the general direction indicated by arrow 'A' in Figure 3, i.e. by flowing through a passage 102*b*, a passage 106 and the outlet means 33.

Said area of overlap is maintained by a spring 79 which urges a flange 72*c* of valve member portion 72*b* against a wall 71*a* of outer member 71, the spring 79 acting between the flange 72*c* and a retaining means 80. The retaining means 80 is held in place, against the urging of spring 79, by a circlip 81. In Figure 3, the upper half of the valve member portion 72*a* is shown in cross-section, and the lower halves of the valve member portion 72*b* and the retaining means 80 are shown in cross-section.

Should the fluid flow between the further opening 77 and the flow passage 78 become excessive by virtue of reaching or exceeding a threshold velocity, differential fluid pressure acting on valve member 72*a*, 72*b* as a result of this fluid flow forces the valve member 72*a*, 72*b* to move to the right, against the urging of the spring 79, from an open position in which said area of overlap exists between the portions 77*a* and 78*a*, to a closed position in which there is no such area of overlap, and in which the valve member 72*a*, 72*b* significantly restricts fluid flow into, and through, the flow passage 78.

Thus, although the urging of the valve member 72*a*, 72*b* towards said open position by the spring 79 ensures that fluid flow is permitted between the further opening 77 and the flow passage 78 for relatively low fluid flow rates, the fluid flow is significantly restricted when the flow rate becomes excessive.

The threshold velocity at or above which the flow of fluid is significantly restricted may be set during manufacture of the shock arrestor 10, for example by adjusting the relative longitudinal positions of respective valve member portions 72*a* and 72*b* and by selecting a spring 79 of an appropriate stiffness.

The threshold velocity of fluid flow is chosen to correspond to a threshold relative speed between the piston 14 and the cylinder 12, and thus corresponds to a threshold speed of the article. Movement of the article at speeds below said threshold speed is permitted, but on excessively rapid movement of the article at a speed at or in excess of said threshold speed, said movement is significantly restrained by the shock arrestor 10 as a consequence of said significant restriction of the fluid flow.

When the valve member 72*a*, 72*b* is caused to move to the right by an excessive fluid flow rate, a further flow passage 32*a* adjacent to the opening 75 in the valve member 72*a*, 72*b* is closed by sealing abutment of a surface 90 of the valve member portion 72*a* with an edge 91 of outer member 71. (As soon as the fluid flow via the further opening 77 and the flow passage 78 has halted, forces due to fluid pressure which are experienced by the valve member 72*a*, 72*b*, cause the continued movement of the valve member 72*a*, 72*b* which results in the closure of said further flow passage 32*a*). Thus fluid flow through the valve means 70 is further restricted as a result of closure of both the flow passage 78 and the further flow passage 32*a*.

When the valve member 72*a*, 72*b* has been moved in this manner to its closed position, pressure of fluid in the valve chamber acting along the passage 31*a* on the end face of the portion 72*b*, retains the valve member in its closed position against the action of the spring 79 as long as the force tending to move the article to which the shock arrestor is attached continues. However, when this force is reduced to below the threshold level, causing the pressure differential between the fluid chambers 20 and 22 to reduce, at the point at which pressure acting on the portion 72*a* reduces to a level less than the force of the spring 79, the portion 72*a*, is permitted to move to the left, and the valve member to its open condition, allowing normal damping of movement of the article.

When the fluid flow is at least significantly restricted, it is desirable that very low "creep" rates of fluid flow should nonetheless be permitted between the chambers 20 and 22 in order to relieve stresses, for example due to thermal expansions or contractions of the fluid and/or the shock arrestor 10 and/or the article or support, which could otherwise cause damage to the shock arrestor 10 and any attached equipment. Therefore, creep means 100, 101, 102*a*, 102*b*, 103, 104, 105, 106 and 107 are provided to permit such creep flow rates when the flow between the chambers 20 and 22 is at least significantly restricted.

The creep means comprises a creep device comprising a spring member 101 acting between a part 100 of the valve means 70 and an end part 105 of the outer member 71 so as normally to urge an end surface 104 of the outer member 71 into sealing abutment against an edge 103 of a further part 107 of the valve means 70. The inlet passage means and the outlet passage means of the shock arrestor 10 are such that an increase in the fluid pressure in either of the chambers 20 and 22, for example as a result of a temperature change, causes an increase in fluid pressure at the inlet means 32 of the valve means 70. Should this increase in pressure become sufficiently great, the fluid pressure at inlet means 32 causes the outer member 71 and valve member 72*a*, 72*b* to be moved to the right, against the urging of the spring member 101, so as to move the end surface 104 away from the edge 103, thereby producing an opening between the end surface 104 and the edge 103, via which opening fluid may be admitted from the inlet means 32 into an auxiliary flow passage 102*a* via which the fluid may reach the passage 102*b* and thence flow through the passage portion 106 in the general direction indicated by arrow 'A' in Figure 3 so as to reach the outlet means 33, and thence flow into the interior of the conduit member 23. This fluid flow out of the inlet means 32 and along auxiliary flow passage 102*a* results in a

reduction in the fluid pressure at the inlet means 32, so that eventually said opening is closed as a result of action of spring member 101. Should the fluid pressure at inlet means 32 again rise, such a "creep" fluid flow will again be permitted as hereinbefore described.

The auxiliary flow passage 102*a* by-passes the flow passage 78.

As shown in the drawings, the flow control means 30 is located within the normal confines of the cylinder 12.

A reserve volume fluid chamber 60 is provided within portion 61 of the bore 25, 61. The reserve volume fluid chamber 60, by virtue of being in communication with the bore portion 25, is in communication with the passage means.

The bore 25, 61 also contains a slidable member 110 urged by a compression spring 125 acting between the slidable member 110 and a further member 111 so as to pressurise the fluid in the reverse volume fluid chamber 60. The further member 111 is substantially fixed with respect to the piston rod portion 16.

The slidable member 110 is mounted for guidance purposes on a guide member 120 which may slide longitudinally within the piston rod portion 16.

If the piston 14 is initially at its extreme left-hand position where it abuts a stop 62, so that the fluid chamber 20 is initially of almost negligible volume, and the piston 14 is then moved to the right, there may be a dramatic reduction in pressure in the fluid chamber 20, said reduction in pressure tending to cause cavitation within the fluid chamber 20. However, said reduction in pressure pulls further poppet member 55 away from the opening 58 so as to open the opening 58, thus permitting pressurised fluid from the reserve volume fluid chamber 60 to be admitted via the outlet passage 37 and the flow route 50, 51 into the fluid chamber 20 in order to reduce risk of such cavitation.

If, on the other hand, the piston 14 is initially at its extreme right-hand position where it instead abuts a further stop 63, so that the fluid chamber 22 is initially of almost negligible volume, and the piston 14 is then moved to the left, there may be a dramatic reduction in fluid pressure within the fluid chamber 22, this reduction in pressure tending to cause cavitation within the fluid chamber 22. However, said reduction in pressure within the fluid chamber 22 pulls further poppet member 56 away from the opening 59 so as to open the opening 59, thus permitting pressurised fluid to be admitted from the reserve volume fluid chamber 60 via the outlet passage 37 and the flow route 52, 53 into the chamber 22 in order to reduce risk of cavitation within the chamber 22.

Changes in the total volume of the fluid and/or the damper 10 may be accommodated by movement of the slidable member 110 within the bore portion 61. Should the pressure of the fluid be such that the slidable member 110 is caused to move substantially to the right-hand extreme of its possible motion within the piston rod portion 16, thermal expansions of the fluid and/or damper may still be accommodated by small movements of the slidable member 110 against a further compression spring 130, of considerable stiffness compared with the compression spring 125, also acting between the slidable member 110 and the part 111, thus reducing risk of damage to the shock arrestor 10 as a result of such thermal expansion.

The substantially cylindrical exterior of the piston 14 is provided with two annular, transversely oriented, longitudinally spaced seals 140, 141 and 145, 146 respectively which slidably abut the inner surface 12*a* of the cylinder 12. Said seals are located in respective annular channels 143 and 144 around the piston exterior. The seals comprise respective outer annular parts 140 and 145 which are urged against the inner surface 12*a* of the cylinder 12 by respective inner annular parts 141 and 146 of the seals. (Our co-pending British Patent Application 8326124 describes and illustrates two transversely oriented longitudinally spaced annular seals, located between a piston exterior and an inner surface of a cylinder, which may be used instead of the seals 140, 141 and 145, 146 of the present application). The exterior of the piston is provided with a further annular channel 150 extending around the piston 14 mid-way between the channels 143 and 144, further channel 150 being in fluid communication with the reserve volume fluid chamber 60 via fluid passage 37 and a fluid passage 155. Thus any fluid lying adjacent to the piston exterior between said seals is maintained at a pressure equal to the pressure of the fluid in the reserve volume fluid chamber 60, thereby avoiding development of excessive fluid pressure between the seals and thereby avoiding seal retention problems which could be caused by such excessive pressure.

The piston 14 comprises two portions 14*a* and 14*b* respectively which are secured together in a back-to-back relationship by a plurality of bolts such as bolt 160 (which is shown to lie behind the outlet passage 37 in Figures 1 and 2) to provide the piston 14.

The piston portions 14*a* and 14*b* are substantially annular. The portion 14*a* is formed in one piece with piston rod portion 16*a*, and portion 14*b* is formed in one piece with the piston rod portion 16. By assembling the piston 14 from the two piston portions 14*a* and 14*b*, the manufacture of the outlet passage means and, in particular, of the inlet passage means, is facilitated.

The piston rod portions 16 and 16*a* are slidably mounted in respective bearings 161 and 162 for longitudinal sliding movement of the piston rod 16, 16*a* and the piston 14.

Sealing means 163 and 164 are provided adjacent to respective bearings 161 and 162 for sliding and sealing engagement with respective piston rod portions 16 and 16*a* to help prevent fluid losses from the chambers 20 and 22. Each of said sealing means 163 and 164 comprises a first annular part and a second annular part, each of said second annular parts urging the respective first annular part radially inwards against the respective piston rod portion. Annular scrapers 165 and 166 scrape respective piston rod portions 16 and 16*a* and thereby help to

prevent potentially harmful foreign matter such as grit from reaching respective sealing means 163 and 164.

Further sealing means 167 and 168, comprising respective elastomeric rings for example, help to prevent fluid losses from occurring between the cylinder wall 12*a* and respective stops 62 and 63.

The left-hand end of piston rod portion 16*a* is closed by a threaded plug 169.

The region of the shock arrestor 10 indicated at 171 is air filled, and expansion or contraction of air in region 171 as the piston 14 and the piston rod 16. 16*a* are moved may usefully contribute to springing in any system into which the shock arrestor 10 is connected.

The further part 107 of the valve means is sealed against the wall of the bore portion 25 by an elastomeric ring 172. In the shock arrestor 10, the inlet means 32 need not extend to the left of the dashed line indicated at 'B' in Figure 3, and will then be as shown in Figure 1. However, in other shock arrestors or in any other devices in which the valve means 70 may be used, it may be more convenient for the inlet means 32 to extend continuously out of the left hand side of further part 107 (as shown by solid lines in Figure 3), in which case sealing against other components may, perhaps more appropriately, be provided by an alternative elastomeric ring 173.

The right-hand end of part 100 is sealed against end 23*b* of conduit member 23 by an elastomeric ring 174. However, in other shock arrestors or any other devices in which the valve means 70 may be used, an alternative elastomeric ring 175 may be provided for sealing said end of part 100 against adjacent components.

The shock arrestor 10 has a user-accessible bleed means (not shown) for bleeding air from the shock arrestor 10, said bleed means comprising a bleed nipple. The shock arrestor 10 is provided with a filling passage 170 for admitting fluid under pressure to the shock arrestor 10. An additional spring loaded poppet member 175 renders the filling passage 170 self-sealing.

The fluid may be a liquid such as a conventional hydraulic fluid.

The shock arrestor 10 may further be provided with a pressure indicating device (not shown) comprising for example a calibrated rod extending from inside a fluid-containing region of the shock arrestor to the outside of the shock arrestor, the rod passing through an aperture in the shock arrestor. The innermost end of the rod may be provided with a first flange, which abuts an elastomeric sealing ring means which lies between said first flange and an inner wall of the shock arrestor 10 and through which the rod passes, and a second flange beyond the first flange at said end, so that a fluid pressure within the shock arrestor in excess of atmospheric pressure forces the rod to move outwardly so that said first flange presses said elastometric sealing ring means against said inner wall of the shock arrestor, the rod moving outwardly to a position corresponding to the excess pressure, the force on the rod due to the excess pressure being balanced at this position by a force on the rod in the opposite direction resulting from compression of the elastomeric sealing ring means by said first flange. Ideally, the final fluid pressure after filling should be sufficient to cause the second flange rigidly and forcefully to abut said inner wall so that the rod does not move significantly during pressure changes arising from operation of the shock arrestor, otherwise backlash may arise in the fluid flow between the chambers. Said elastomeric sealing ring means may comprise one elastomeric ring or a mutually abutting plurality of such rings arranged in succession along the rod. Said flanges may be substantially annular or circular.

Said article whose movement is restrainable by the shock arrestor 10 may if desired be connected solely to shock arrestor 10. The shock arrestor would then provide conventional damping at said relatively low speeds as a consequence of the fluid having to flow between the chambers 20 and 22 via the passage means in response to movement of the article and the piston 14, but would at least significantly restrain movement of the article should the speed of the article become excessive. Alternatively, the article may if desired be connected to the shock arrestor 10 in combination with, for example, a conventional damper, some or most of the damping then being provided by said damper, the shock arrestor 10 then being present primarily for restraining movement of the article should the speed of the article become excessive.

Although the creep means has been described as operating in response to thermal expansions or contractions of the fluid and/or shock arrestor 10 and/or the article or the support, it may also operate in response to application of any continuous high load to the shock arrestor 10 and/or the article or the support.

The shock arrestor 10 may, for example, be used to restrain excessively fast movement of a portion of a pipeline to which it could be connected, in which case it may be appropriate during manufacture to set the valve means 70 so as significantly to restrict fluid flows corresponding to pipeline speeds greater than or equal to say, a threshold speed of approximately 0.1 m per second.

Although the valve device 30 has been described primarily with reference to its operation in the shock arrestor 10, the valve device 30 may be used in any fluid-employing device as a means for permitting fluid flow within the fluid-employing device at relatively low flow rates but at least significantly restricting such flow when the flow rate becomes excessive.

CLAIMS

1. A shock arrestor of the kind specified wherein the flow control means is operative to permit flow between the chambers at relatively low flow rates but at least significantly to restrict such flow when the flow rate becomes excessive.

2. A shock arrestor according to Claim 1 wherein the flow control means further comprises valve means which under normal conditions of operation is in an open condition and which on excessive

pressure differential between the first and second chambers moves or is moved to a closed condition in which it provides a significant restriction to flow of fluid therethrough.

3. A shock arrestor according to one of Claims 1 and 2 wherein fluid flow between said chambers in either direction results in the same direction of flow of fluid through the valve means.

4. A shock arrestor according to one of Claims 2 and 3 wherein when the valve means is in its closed condition, flow of fluid between the two chambers through the valves means is substantially prevented, and the valve means is retained in its closed position by the pressure differential between said chambers.

5. A shock arrestor according to Claim 4 wherein when the pressure differential reduces to a level below said excessive level, the valve means is moved to its open condition.

6. A shock arrestor according to any one of the preceding claims wherein the flow control means comprises means which permits some fluid flow between the two chambers whilst the valve means is in its closed condition.

7. A shock arrestor according to Claim 6 wherein said means is afforded by a by-pass channel which under normal conditions is closed, but through which fluid may flow under certain circumstances.

8. A shock arrestor according to any one of the preceding claims wherein the flow control means is located substantially within the normal confines of the cylinder.

9. A shock arrestor according to any one of Claims 1 to 8 wherein the flow control means is located substantially within a piston rod which moves with the piston.

10. A shock arrestor according to Claim 9 where appendant at least to Claim 8 wherein the passage means comprises a bore formed in the piston rod, the flow control means being located within the bore, an inlet passage means being provided to admit fluid unidirectionally from either chamber to an inlet means of the flow control means, and an outlet passage means being provided to admit fluid unidirectionally to either chamber from an outlet means of the flow control means.

11. A shock arrestor of the kind specified wherein the flow control means is located within a piston rod movable in the cylinder with the piston.

12. A shock arrestor of the kind specified comprising a valve chamber in which the flow control means is located, and valve means in the valve chamber, means being provided which is operative to produce unidirectional flow of fluid through the valve chamber in both directions of movement of the piston.

13. A shock arrestor according to Claim 11 wherein the valve chamber is located within a piston rod movable in the cylinder with the piston.

14. A shock arrestor according to any one of the preceding claims further comprising a reserve volume fluid chamber in communication with the passage means.

15. A shock arrestor according to Claim 14 wherein the reserve volume fluid chamber is located in a region of the shock arrestor also containing a slidable member urged by a compression spring acting between the slidable member and a part of said region so as to pressurize the fluid in the reserve volume fluid chamber.

16. A shock arrestor according to Claim 15 further comprising a further compression spring acting between said slidable member and said part.

17. A shock arrestor according to one of Claims 15 and 16 where appendant at least to Claim 14 wherein said region lies within the piston rod.

18. A shock arrestor according to any one of the preceding claims having an indicator visible from outside the shock arrestor showing the pressure of the fluid within the shock arrestor.

19. A shock arrestor according to any one of the preceding claims having a user-accessible drain means for emptying the fluid from the shock arrestor and a user-accessible self-sealing filling passage for admitting fluid under pressure to the shock arrestor.

20. A shock arrestor of the kind specified further comprising a reserve volume fluid chamber in communication with the passage means.

21. A shock arrestor according to Claim 20 wherein the piston exterior is provided with two annular, transversely oriented, longitudinally spaced seals which slidably abut the inner surface of the cylinder, the seals being located in respective annular channels around the piston exterior and each having an outer annular part which is urged against the cylinder by respective inner annular parts of the seals, the exterior of the piston at a location between the seals being in fluid communication with the reverse volume fluid chamber.

22. A shock arrestor of the kind specified wherein the piston is formed from two substantially circular or annular portions secured to each other in back-to-back relationship.

23. A flow control means suitable for use in a shock arrestor of the kind specified, comprising a valve means comprising at least one flow passage through which fluid flows during normal operation of the shock arrestor and a valve member operative in relation to the flow passage and which is movable from an open position to a closed position by differential fluid pressure acting on the valve member when the fluid flow reaches or exceeds a threshold velocity.

24. A flow control means according to Claim 23 wherein the normal fluid flow is through an aperture in a surface of the valve member and a further aperture at an end of said flow passage, said further aperture lying in a further surface of the valve device, said surface and said further surface slidably abutting each other, said apertures at least partially overlapping each other when the valve member is at the open position, but not overlapping each other when the valve member has moved to the closed position.

25. A flow control means according to Claim 24 wherein said movement of the valve member from the open position to the closed position additionally causes closure of a further fluid passage through

which fluid flows during normal operation of the shock arrestor or other fluid-employing device.

26. A flow control means according to Claim 25 having a creep device comprising a component which is urged so as normally to close an opening of an auxiliary flow passage by-passing said flow passage, said component being movable against said urging so as to open the opening and permit fluid flow along said auxiliary passage.

27. A shock arrestor according to any one of Claims 1 to 22 comprising a flow control means according to any one of Claims 23 to 26.

28. A shock arrestor substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

29. A flow control means substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

30. A method of permitting movement of an article at relatively low speeds, but at least significantly restraining movement of said article when the speed of the article becomes excessive, by connecting the article to a shock arrestor according to any one of Claims 1 to 22.

31. A method of permitting fluid flow at a relatively low flow rates, but at least significantly restricting such flow when the flow rate becomes excessive, using a flow control means according to any one of Claims 23 to 26.

32. Any novel feature or novel combination of features disclosed herein and/or shown in the accompanying drawings.

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